

## CHAPTER I

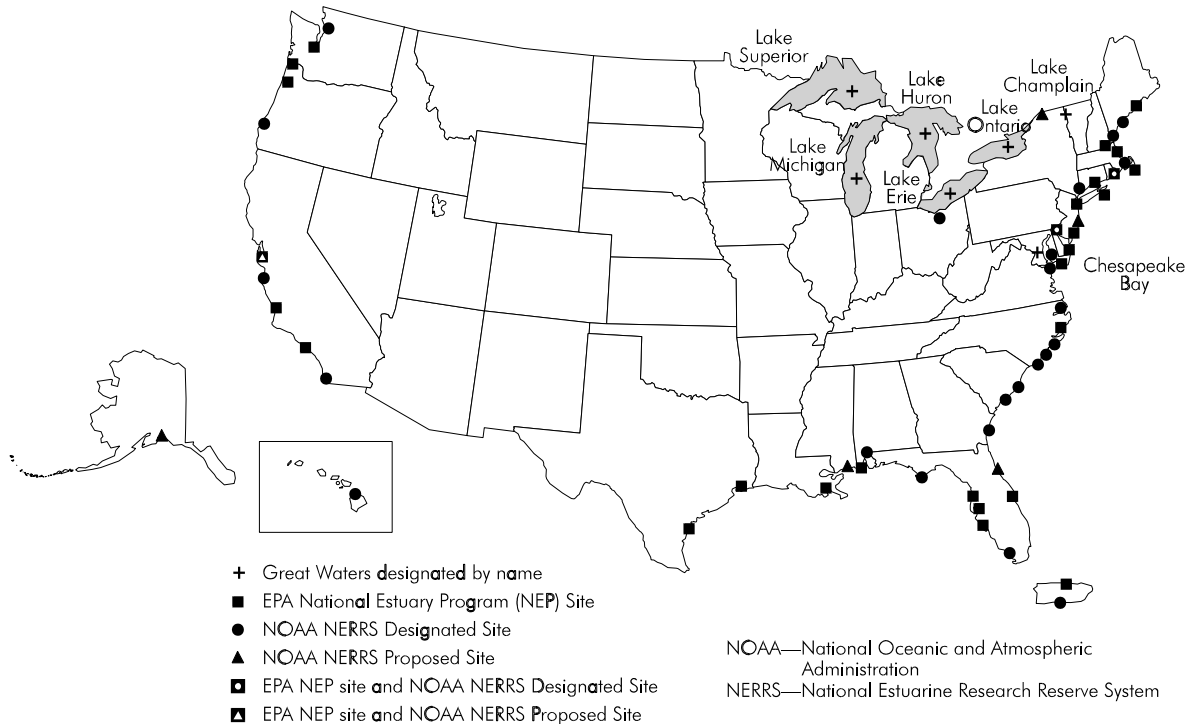
### OVERVIEW OF THE GREAT WATERS PROGRAM

Section 112 of the Clean Air Act (CAA) provides the legislative basis for hazardous air pollutant (HAP) programs directed by the U.S. Environmental Protection Agency (EPA). In response to mounting evidence that air pollution contributes to water pollution, Congress included section 112(m), *Atmospheric Deposition to Great Lakes and Coastal Waters*, in the 1990 Amendments to the CAA to establish research, reporting, and potential regulatory requirements related to atmospheric deposition of HAPs to the "Great Waters." EPA coordinates activities to address the requirements of section 112(m) under the Great Waters program.

This report fulfills the requirements in section 112(m)(5), which directs EPA, in cooperation with National Oceanic and Atmospheric Administration (NOAA), to periodically submit a Report to Congress on atmospheric deposition to the Great Waters. The report is to describe "results of any monitoring, studies, and investigations conducted pursuant to" section 112(m). The First Report to Congress on atmospheric deposition to the Great Waters, referred to throughout this report as the "First Report to Congress," was published in May 1994 (U.S. EPA 1994a). This document is the Second Report to Congress and is intended to be an update of the information presented in the First Report to Congress.

The waterbodies collectively referred to as the "Great Waters" in this report are the Great Lakes, Lake Champlain, Chesapeake Bay, and specific coastal waters (i.e., defined in the statute as coastal waters designated through the National Estuary Program and the National Estuarine Research Reserve System). (See Figure I-1 for the locations of these waterbodies.)

**FIGURE I-1**  
**Locations of the Great Waters**



## I.A The Second Report to Congress

### *Goals of the Report*

The main objective of this report is to update what is known about atmospheric deposition of pollutants to the Great Waters based on the scientific data available since publication of the First Report to Congress. The report focuses on research and activities in specific waterbodies to further understand and promote reductions of overall contaminant loadings to the Great Waters. In addition, this report includes a brief discussion of EPA's draft determination of the adequacy of section 112 to protect the Great Waters from deposition of HAP emissions from domestic stationary sources (see Chapter V).

EPA intends for this report to be an **update** of the First Report to Congress and has attempted to minimize restating information. In some instances, important findings or issues raised in the First Report to Congress are reiterated in this report to provide background information or to highlight an issue that continues to be significant to the Great Waters. For more detailed information on atmospheric deposition to the Great Waters, readers are encouraged to refer to the First Report to Congress (U.S. EPA 1994a), which summarized the scientific understanding of atmospheric deposition at that time and identified regulatory and research needs.

The scientific information presented in this report, together with the findings and recommendations identified in the First Report to Congress, should be used together to assess the progress since the First Report to Congress, and what data gaps still exist. Because of the short time period since the First Report to Congress, projects that were initiated after the release of the report or multi-year fieldwork projects, in most instances, are still in the data-gathering stage. Therefore, the results of these efforts cannot yet be analyzed. However, the objectives and status of these efforts are described in the report.

As in the First Report to Congress, the Second Report shows that data on effects, loadings, and sources are available to a certain extent; however, information to assess the linkage between these components remains inadequate, and therefore, unanswered questions, as well as uncertainties, persist for some of these issues. This report proposes a number of future directions (see Chapter V) to reduce uncertainty in several areas.

### *Report Preparation*

The information in this report was collected from several sources. The references cited are generally from published peer-reviewed journals, government reports, and conference proceedings. The report uses sources that provide relevant information on Great Waters issues, but does not attempt to be comprehensive in the references cited. In general, literature published by late fall 1996 is included. Data on human health and ecological effects of pollutants of concern are based on a search for scientific literature published between completion of the background document on exposure and effects from the First Report to Congress (Swain et al. 1992a) through 1995. In a few instances throughout the report, more recent articles are included. In addition, in sections that are new to this report, older articles may be cited. Interested parties who know of other studies that may be pertinent to issues regarding atmospheric deposition to the Great Waters are encouraged to submit a copy of the article or a complete citation of the reference to EPA. Every effort will be

made by EPA to review the article and to determine whether the information is relevant for the Third Report to Congress on atmospheric deposition to the Great Waters.

In addition to literature searches for current information on effects, current scientific information about atmospheric deposition to the Great Waters was compiled from two symposia held at the annual meeting of the Society of Environmental Toxicology and Chemistry (SETAC) in Denver, Colorado, from October 31 through November 4, 1994. Invited researchers presented findings from current research relevant to the Great Waters program. These findings have been assembled in a book entitled *Atmospheric Deposition of Contaminants to the Great Lakes and Coastal Waters* (Baker 1997).<sup>1</sup> In addition, EPA incorporated findings from recent investigations that have been funded by and/or conducted in connection with the Great Waters program, and has integrated findings from other significant EPA projects such the reassessment of dioxin and dioxin-like compounds (U.S. EPA 1994c, 1994d). Much of the waterbody-specific information presented in this report was provided by the EPA offices that coordinate investigation, restoration, and maintenance efforts in that waterbody (e.g., Great Lakes National Program Office, Chesapeake Bay Program Office).

The available waterbody-specific information on deposition of air pollutants focuses in large part on the Great Lakes and Chesapeake Bay. The Great Lakes have been a focus of the Great Waters Reports to Congress because, with their importance as the largest freshwater system in the United States and the observations reported for decades of toxic contamination in organisms living in the Great Lakes, there exists the best base of information on which to build. In addition, studies from the 1980s show atmospheric deposition to be a significant route of introducing pollutants to the Lakes. Knowledge gained of the conditions of the Great Lakes is useful in evaluating atmospheric deposition in other freshwaters as well. For example, researchers at Lake Champlain have developed scientific programs to determine the role of atmospheric deposition, particularly mercury, in water pollution. This report also focuses on Chesapeake Bay because accelerated eutrophication and its effects on the Bay have been recognized for over a decade. Accelerated eutrophication in the Bay is attributed, in part, to nitrogen loadings deposited from the atmosphere to the surrounding watershed, as well as directly into the Bay itself. Similar circumstances affect other U.S. estuaries, and information collected and applied in Chesapeake Bay will be useful for these waterbodies. For example, EPA has sponsored studies to refine the methodology used for estimating sources of nitrogen in Chesapeake Bay and to apply the methodology to estuaries in Galveston Bay, Texas, and Tampa Bay, Florida. A discussion of atmospheric deposition specific to each of the Great Waters — Great Lakes, Lake Champlain, Chesapeake Bay, and other coastal waters — is presented in Chapter IV.

The remaining sections of this chapter provide an overview of the findings from the First Report to Congress, as well as recent research activities in the Great Waters, followed by discussion of the air pollutants that are of particular concern to the Great Waters.

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<sup>1</sup> Baker (1997) was still in press as of June 30, 1997.

## I.B The First Report to Congress

The objective of the First Report to Congress was to describe what was known about atmospheric deposition of toxic chemicals to the Great Waters and present any appropriate regulatory recommendations based on the scientific information available at the time. The scientific content of the First Report to Congress was based mainly on three background documents prepared by committees of leading independent scientists (Baker et al. 1993; Keeler et al. 1993; Swain et al. 1992a). The information in these documents was used to answer three main scientific questions, develop scientific and policy conclusions, and recommend next steps. The three scientific questions were:

1. What human health and environmental effects are associated with the pollutants of concern in the Great Waters?
2. What is the relative importance of atmospheric deposition in causing contamination in the Great Waters?
3. What sources are significant contributors to atmospheric loadings to the Great Waters?

From the data compiled, three general responses to these questions were developed:

- ◆ Adverse effects (e.g., cancer, developmental effects) in humans and animals associated with exposure to the Great Waters pollutants of concern are fairly well understood. However, data are insufficient to establish a quantitative link between atmospheric deposition of these pollutants and their related effects.
- ◆ Atmospheric deposition can be a significant contributor of toxic chemicals to the Great Waters. The relative importance of atmospheric loading for a particular chemical in a given waterbody depends on characteristics of the waterbody, properties of the chemical, and the kind and amount of airborne, waterborne, and other sources.
- ◆ Many sources and source categories of pollutants of concern to the Great Waters have been identified. However, identification of particular sources responsible for the deposited pollutants in specific waterbodies is complicated since atmospheric loadings can originate from local, regional, and global sources.

Specific conclusions from the First Report to Congress, based on scientific data available at that time, included:

- ◆ Persistence and the tendency to bioaccumulate, critical characteristics of the Great Waters pollutants of concern, result in potentially greater human and ecological exposure to a pollutant in the environment.
- ◆ Exceedances of water quality criteria and standards have occurred for some of the pollutants in some waterbodies.

- ◆ Adverse effects on human health and wildlife have been observed due to exposure, especially through fish consumption, to persistent pollutants that bioaccumulate.
- ◆ In addition to cancer, noncancer effects (e.g., nervous system damage, immunological effects) caused by the pollutants can be a significant human health concern, and may affect some individuals exposed to levels above certain thresholds. Developing embryos and fetuses and breast-fed infants are given greater attention because they may be more susceptible than the general population to the adverse effects of these chemicals.
- ◆ Ecological effects on animal populations due to the pollutants of concern can be significant, such as immune function impairment, reproductive problems, and neurological changes that affect survival. Sometimes the effects on wildlife may be delayed and/or the symptoms subtle so that the effects are easily overlooked.
- ◆ Eutrophication resulting from excess nitrogen inputs is a major problem in some U.S. estuarine and coastal waters, and the relative contribution from atmospheric deposition of nitrogen to this problem can be significant. Ecological effects, ranging from nuisance algal blooms to oxygen depletion and fish kills, and adverse economic impacts to the waterbody region may result.
- ◆ Case studies have shown that atmospheric deposition can be a major contributor of mercury, nitrogen, polycyclic organic matter (POM), and polychlorinated biphenyls (PCBs) in waterbodies. The available information generally includes relative loadings estimates. Attention also should be given to the absolute quantity of the loadings because even small amounts of pollutants that bioaccumulate may produce a significant burden in fish and, ultimately, in humans and other fish-eating animals.
- ◆ Airborne emissions from both local and distant sources contribute to atmospheric deposition of pollutants to waterbodies. Deposition patterns can be influenced by characteristics of the pollutants and the source, and by weather and transport patterns.
- ◆ Continued research is needed, especially to help determine atmospheric contributions, to identify sources, to evaluate effects from low exposure levels, and to target HAPs that may pose the most significant risk to human health and aquatic resources.

Readers should refer to the First Report to Congress for discussion of the specific conclusions.

Based on the scientific conclusions in the First Report to Congress, EPA's principal policy conclusion was that reasonable actions are justified by the available scientific information, even though there are significant uncertainties associated with this information. While additional research is needed to reduce these uncertainties, reasonable actions to decrease atmospheric loadings need not wait for results of such information. To carry out its policy conclusion, EPA identified several recommendations for action, which were divided into three strategic themes:

1. EPA will continue ongoing efforts to implement section 112 and other sections of the CAA, as amended in 1990, and use the results of the First Report to Congress in the development of policy that will reduce emissions of the Great Waters pollutants of concern.

2. EPA recognizes the need for an integrated multimedia approach to the problem of atmospheric deposition of pollutants to waterbodies and, therefore, will utilize authorities beyond the CAA to reduce the human and environmental exposure to Great Waters pollutants of concern.
3. EPA will continue to support research activities and will develop and implement a strategy describing necessary research and policy assessments to address the mandates of section 112(m).

The specific action items based on these three strategic themes are described in detail in the First Report to Congress. The current status of each of the recommended action items is presented in Appendix A.

## I.C Highlights of Progress Since the First Report to Congress

Much progress has been made since the First Report to Congress on research and other activities related to atmospheric deposition, especially activities that support section 112(m) mandates (see sidebar). The activities described in this report include those carried out by many national and regional EPA offices, as well as NOAA and a number of states (i.e., the programs and research were not all performed by the Great Waters program in EPA's Office of Air and Radiation). This report does not, however, attempt to be comprehensive in describing all the activities of these offices. A brief overview of some of the activities undertaken is presented below.

- ◆ EPA has worked with the Great Lakes States to continue development of regional emission inventories for the Great Lakes and a data storage and retrieval system. Data collection was recently completed, and the data base will be updated

### **EPA Activities Addressing Section 112(m) Requirements**

Section 112(m) directs EPA, in cooperation with NOAA, to identify and assess the extent of atmospheric deposition of toxic pollutants to the Great Waters. As part of the assessment, EPA supports the following activities:

- Monitoring of atmospheric deposition, including the establishment of monitoring networks in the Great Lakes, Chesapeake Bay, Lake Champlain, and coastal waters;
- Investigation of sources and deposition rates of air pollutants;
- Research for developing and improving monitoring methods and for determining the relative contribution of atmospheric pollutants to total pollutants in the Great Waters;
- Evaluation of adverse human health and environmental effects;
- Identification of exceedances of water quality and drinking water standards;
- Sampling of fish and wildlife for pollutants of concern;
- Characterization of sources of pollutants of concern; and
- Determinations of whether section 112 authority is "adequate to prevent serious adverse effects to public health and serious or widespread environmental effects" associated with atmospheric deposition of HAPs to the Great Waters, and of whether further emissions standards or control measures to prevent such effects are necessary and appropriate. Based on these determinations, EPA is directed to take additional measures, as necessary and appropriate, to prevent such adverse effects to human health and the environment.

annually. Work will continue to characterize mobile source emissions and to improve the accuracy of the emissions inventory. Determining, categorizing, and estimating the magnitude of pollutant sources will be a significant step toward reduction of atmospheric loading of pollutants to the Great Lakes.

- ◆ Quantitative data continue to be gathered on atmospheric deposition of pollutants including PCBs, DDT, dieldrin, and lindane in each of the Great Lakes through the Integrated Atmospheric Deposition Network (IADN) (a joint U.S./Canadian monitoring network). Recent data have been incorporated into deposition estimates for 1994, thereby allowing comparison of data to 1992 results.
- ◆ Atmospheric mercury concentration and deposition have been monitored continuously in the Lake Champlain region in the last few years, which will be important for determining atmospheric deposition trends in the lake basin.
- ◆ A large-scale airshed model for Chesapeake Bay has been developed to determine the general geographical location and type of sources of nitrogen emissions, and the relative contributions of different sources and patterns of nitrogen deposition to the Bay watershed and directly to tidal surface waters. Models of the Chesapeake Bay airshed, watershed, and tidal waters were extensively revised to link daily atmospheric deposition loading data to models of water quality impacts in the tidal Bay and resultant influences on Bay underwater grasses, bottom benthic communities, and overlying fish habitat.
- ◆ The Chesapeake Bay Atmospheric Deposition Study (CBADS) network was established and the resultant data have been used to quantify atmospheric loadings and depositional fluxes of toxic contaminants to the Bay, as part of the development of a larger basinwide chemical contaminant loading and release inventory.
- ◆ Research stations have been established to measure atmospheric deposition of nitrogen and other selected pollutants in Tampa Bay, Galveston Bay, and Pamlico Sound and adjacent estuaries (e.g. Neuse River Estuary, Newport River Estuary); collected data will be used to determine annual atmospheric loadings of these pollutants and the relative contribution of remote and local sources to atmospheric deposition in the waterbodies.

Chapter IV of this Report to Congress provides more details on the activities highlighted above.

## **I.D Pollutants of Concern**

### ***Great Waters Pollutants of Concern and Reasons for Inclusion***

As did the First Report to Congress, this report focuses on selected pollutants of concern (see sidebar on next page). These pollutants are potentially of concern for atmospheric deposition

to the Great Waters.<sup>2</sup> The general types of sources and uses (and use restrictions) of these pollutants are briefly summarized in Table I-1.

The list of 15 Great Waters pollutants of concern has not been expanded since the First Report to Congress. Three pesticides, atrazine, hexachlorobutadiene, and methoxychlor, mentioned in the First Report, continue to be considered by EPA as potential future additions to the Great Waters list of pollutants of concern. Atrazine warrants continued attention as a potential pollutant of concern because of its widespread occurrence (e.g., commonly used in the Great Lakes basin), its at-least moderate persistence, and its potential to cause a variety of effects on biota. For these reasons, atrazine is also one of the chemicals of focus for the Lake Michigan Mass Balance Study (discussed in Chapter IV). The other two pesticides under consideration for future addition, hexachlorobutadiene and methoxychlor, are both on the CAA HAPs list and have the potential to bioaccumulate in the food web. Additional information suggests that atrazine and methoxychlor are potential endocrine disruptors, a group of chemicals that mimic or otherwise interfere with hormones in the body, resulting in various adverse biological effects.

#### **Great Waters Pollutants of Concern**

Cadmium and cadmium compounds  
Chlordane  
DDT/DDE  
Dieldrin  
Hexachlorobenzene (HCB)  
 $\alpha$ -Hexachlorocyclohexane ( $\alpha$ -HCH)  
Lindane ( $\gamma$ -hexachlorocyclohexane;  $\gamma$ -HCH)  
Lead and lead compounds  
Mercury and mercury compounds  
Polychlorinated biphenyls (PCBs)  
Polycyclic organic matter (POM)  
Tetrachlorodibenzo-p-dioxin, 2,3,7,8-  
(TCDD; dioxins)  
Tetrachlorodibenzofuran, 2,3,7,8-  
(TCDF; furans)  
Toxaphene  
Nitrogen compounds

#### Under Evaluation for Addition to Great Waters List

Atrazine  
Hexachlorobutadiene  
Methoxychlor

The 15 pollutants of concern for the Great Waters were selected based on available data on their effects and deposition. Reasons for selecting these pollutants include:

- ◆ All the pollutants, except for nitrogen compounds, persist in the environment and/or have a high potential to accumulate in living organisms. All the pollutants can cause adverse effects in humans and the environment.
- ◆ All 15 pollutants are known air pollutants and are known to be present in atmospheric deposition (e.g., rainfall, dry deposition).
- ◆ Data indicate that these pollutants are present in the waters and biota of the Great Waters and that one route of pollutants to these waterbodies is atmospheric deposition.

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<sup>2</sup> The pollutants of concern are not considered to be inclusive of *all* chemicals that may, now or in the future, be an important component of atmospheric deposition to the Great Waters. While nitrogen is not listed as a HAP under section 112(b) of the CAA, this report examines the contribution of excess levels of nitrogen to eutrophication. Acidification or "acid rain" is not discussed because it is addressed under a separate CAA program.

**TABLE I-1**  
**Pollutants of Concern in the Great Waters<sup>a</sup>**

Pollutant	Examples of Uses <sup>b</sup>
Cadmium and compounds	Naturally occurring element used in metals production processes, batteries, and solder. Often released during combustion of fossil fuels and waste oil, and during mining and smelting operations.
Chlordane	Insecticide used widely in the 1970s and 1980s. All U.S. uses except termite control cancelled in 1978; use for termite control voluntarily suspended in 1988. Use of existing stocks permitted.
DDT/DDE	Insecticide used widely from introduction in 1946 until significantly restricted in U.S. in 1972. Still used in other countries. Used in U.S. for agriculture and public health purposes only with special permits.
Dieldrin	Insecticide used widely after introduction in late 1940s. Used in U.S. for termite control from 1972 until registration voluntarily suspended in 1987.
Hexachlorobenzene	Fungicide used as seed protectant until 1985. By-product of chlorinated compound and pesticide manufacturing. Also a by-product of combustion of chlorine-containing materials. Present as a contaminant in some pesticides.
$\alpha$ -Hexachlorocyclohexane ( $\alpha$ -HCH)	Component of technical-HCH, an insecticide for which use is restricted in U.S., but which is used widely in other countries.
Lindane ( $\gamma$ -Hexachlorocyclohexane; $\gamma$ -HCH)	An insecticide used on food crops and forests, and to control lice and scabies in livestock and humans. Currently used primarily in China, India, and Mexico. U.S. production stopped in 1977. Use was restricted in 1983; however, many uses are still registered, but are expected to be voluntarily cancelled in the future.
Lead and compounds	Naturally occurring element commonly used in gasoline and paint additives, storage batteries, solder, and ammunition. Released from many combustion and manufacturing processes and from motor vehicles. Use in paint additives restricted in U.S. in 1971. U.S. restrictions on use in gasoline additives began in 1973 and have continued through the present, with a major use reduction in the mid-1980s.
Mercury and compounds	Naturally occurring element often used in thermometers, electrical equipment (such as batteries and switching equipment), and industrial control instruments. Released from many combustion, manufacturing, and natural processes. Banned as a paint additive in U.S. in both interior (1990) and exterior (1991) paint.
Polychlorinated biphenyls (PCBs)	Industrial chemicals used widely in the U.S. from 1929 until 1978 for many purposes, such as coolants and lubricants and in electrical equipment (e.g., transformers and capacitors). In the U.S., manufacture stopped in 1977 and uses were significantly restricted in 1979. Still used for some purposes because of stability and heat resistance, and still present in certain electrical equipment used throughout the United States.
Polycyclic organic matter (POM) <sup>c</sup>	Naturally occurring substances that are by-products of the incomplete combustion of fossil fuels and plant and animal biomass (e.g., forest fires). Also, by-products from steel and coke production and waste incineration.
TCDD (dioxins)	By-product of combustion of organic material containing chlorine, chlorine bleaching in pulp and paper manufacturing, and diesel-fueled vehicles. Also a contaminant in some pesticides.
TCDF (furans)	By-product of combustion of organic material containing chlorine, chlorine bleaching in pulp and paper manufacturing, and diesel-fueled vehicles. Also a contaminant in some pesticides.
Toxaphene	Insecticide used widely on cotton in the southern U.S. until the late 1970s. Most U.S. uses banned in 1982; remaining uses cancelled in 1987.
Nitrogen compounds	By-products of power generation, industrial, and motor vehicle fossil fuel combustion processes ( $\text{NO}_x$ and $\text{NH}_3$ ). Also, compounds used in fertilizers and released from agricultural animal manures ( $\text{NH}_3$ ).

<sup>a</sup> Source: See the First Report to Congress for references for this table (U.S. EPA 1994a).

<sup>b</sup> Applicable restrictions (including bans) on use or manufacture in United States also are described.

<sup>c</sup> POM is a large class of chemicals consisting of organic compounds having multiple benzene rings and a boiling point greater than 100° C. Polycyclic aromatic hydrocarbons (PAHs) are a chemical class that is a subset of POM.

- ◆ These pollutants overlap substantially with the toxic air pollutants that ranked highest in an EPA-sponsored study (ICF 1991) to identify priority chemicals having characteristics that lead to potential adverse effects in the Great Waters.
- ◆ With the exception of dieldrin and nitrogen compounds, all of these pollutants are listed as HAPs under section 112(b) of the CAA.<sup>3</sup>
- ◆ With the exception of 2,3,7,8-TCDF and nitrogen compounds, these pollutants are included on the list of pollutants that were the initial focus of the EPA/state Great Lakes Water Quality Initiative.<sup>4</sup> They are considered to be potentially significant as air pollutants deposited to the Great Lakes.
- ◆ Ten of the 15 pollutants are designated as bioaccumulative chemicals of concern under EPA's Great Lakes Water Quality Guidance.<sup>5</sup>
- ◆ Six of the 15 pollutants (cadmium, chlordane, lead, mercury, PCBs, and several PAHs (which are part of the POM class of compounds)) are on the Chesapeake Bay Toxics of Concern List,<sup>6</sup> and two more pollutants, dieldrin and toxaphene, are listed as potential future additions to this list.
- ◆ Nitrogen compounds play an important role in excessive nutrient enrichment in many estuaries and coastal waters, and numerous studies indicate that atmospheric loadings of nitrogen to the Chesapeake Bay and other coastal waters are a significant portion of total nitrogen loadings. In most freshwaters, nitrogen compounds play a less immediate role in promoting excessive enrichment. For example, airborne nitrogen compounds are not of concern currently in the Great Lakes.
- ◆ The pollutant list overlaps substantially with several sets of Great Lakes chemicals of concern selected by other scientific and regulatory groups, including the Great Lakes Water Quality Board (GLWQB) of the International Joint Commission (IJC), a cooperative committee comprised of U.S. and Canadian representatives.

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<sup>3</sup> Several pollutants of concern are listed by a different name in section 112(b). The pollutants of concern are listed in section 112(b) as: cadmium compounds, chlordane, DDE, hexachlorobenzene, lindane (all isomers, which includes  $\alpha$ -HCH), lead compounds, mercury compounds, PCBs, POM, 2,3,7,8-TCDD, dibenzofurans, and toxaphene. In addition, hexachlorobutadiene and methoxychlor are listed in section 112(b).

<sup>4</sup> Established in 1989 to provide consistent level of environmental protection for the Great Lakes ecosystem, this Initiative supported principles and goals of the 1986 Great Lakes Toxic Substances Control Agreement (Governors' Agreement).

<sup>5</sup> The Final Water Quality Guidance for the Great Lakes System was released in 1995 (60 *Federal Register* 15366) and resulted in the deletion of six chemicals (including aldrin, endrin, methoxychlor) from the proposed 1993 list of bioaccumulative chemicals of concern. The final guidance also eliminated the list of 10 pollutants considered potential bioaccumulative chemicals of concern. Although furans (2,3,7,8-TCDF) are not specified in the 1995 guidance, criteria for furans may eventually be set.

<sup>6</sup> Atrazine is also found on the Chesapeake Bay Toxics of Concern List.

## *Use of Pollutant Groups*

In some sections of this report, discussion of the Great Waters pollutants of concern is organized by pollutant group. The five pollutant groups used in this report are described below. Many of the pollutants may fit into more than one group, but have been placed in the most appropriate category.

EPA has organized the pollutants of concern in these five groups for several reasons. First, the pollutants in each group generally originate from similar sources or are released through similar mechanisms. Thus, action proposed to reduce emissions of individual pollutants may be applied more broadly to the entire group. Second, pollutants in each group may have similar chemical characteristics, allowing for generalizations related to deposition and cycling within the environment. Third, separating the pollutants into various groups allows for pollutants with unique regulatory concerns, such as mercury and nitrogen, to be highlighted and emphasized in the Report to Congress. Finally, grouping the pollutants helps decision-makers develop conclusions about pollutants with similar chemical/physical behavior or sources, where there are limited data.

- ◆ **Mercury and mercury compounds.** Mercury is released as an air pollutant from a variety of natural and anthropogenic area and point sources (including combustion and manufacturing sources). Although mercury is a metal, it is treated in this report as a separate pollutant group because it behaves differently in the environment than other metals and produces different types of effects, as well as because of the comprehensive data that are available for it. Mercury can be found in elemental, inorganic, or organic forms in the environment. In aquatic species, mercury exists primarily as organic mercury (e.g., methylmercury), which can bioaccumulate in tissues and biomagnify in the food web. In addition, special emphasis is given to mercury emissions in the CAA. Several subsections of section 112 require studies to be conducted on mercury as a toxic air pollutant; a review draft of an EPA report related to atmospheric emissions of mercury was submitted to the Science Advisory Board (SAB) in 1996. When submitted to Congress, the final Mercury Study Report will fulfill the mandate under CAA section 112(n)(1)(B) that the study consider:
  - The rate and mass of mercury emissions;
  - The health and environmental effects of such emissions;
  - Technologies that are available to control such emissions; and
  - The cost of these control technologies.
- ◆ **Other metals.** Cadmium compounds and lead compounds comprise this group. These metal compounds are released from various combustion and production processes. Note, however, that a significant source of lead was reduced following the phaseout of lead in gasoline additives that began in the early 1970s.
- ◆ **Combustion emissions.** The pollutants in this group include PCBs, POM, 2,3,7,8-TCDD, and 2,3,7,8-TCDF. (See the sidebar on the next page for a discussion of TCDD and TCDF.) These pollutants generally are released during incomplete combustion of fossil fuels and/or combustion during manufacturing or incineration processes. PCBs, though historically used in electrical equipment and hydraulic fluids, are included in this group because they may be released to the atmosphere in combustion gases when PCB-containing materials are burned.

◆ **Pesticides.** This group includes chlordane, DDT/DDE, dieldrin, hexachlorobenzene,  $\alpha$ -HCH, lindane, and toxaphene. Although the use of these pesticides is significantly limited in the United States, they continue to be of concern in the Great Waters because of their persistence in the environment and the long-range transport from other countries in which the pesticides are still used. Atrazine, hexachlorobutadiene, and methoxychlor are potential future additions to this group.

◆ **Nitrogen compounds.** This group includes nitrogen oxides, reduced nitrogen compounds (such as ammonia and ammonium), and organic nitrogen. These pollutants are released through both natural and anthropogenic pathways.

Although nitrogen oxides are fossil fuel combustion by-products, nitrogen compounds are treated as a separate pollutant group because: (1) other measures are being taken to control nitrogen through programs related to ground-level ozone and acid precipitation; (2) nitrogen, unlike the other selected pollutants of concern, is an essential nutrient and is not listed as a HAP under CAA section 112(b); and (3) when present in excessive amounts, nitrogen (in oxides and other compounds that are plant nutrients) is the nutrient driving the accelerated eutrophication of most estuarine and coastal waters, resulting in significant adverse ecosystem effects. Unlike the other pollutants, nitrogen is a required nutrient that supports the ecosystem and becomes a pollutant when it reaches levels that result in overfertilization with deterioration of water quality.

### Dioxins and Furans

Section 112(b) of the CAA includes in its list of HAPs "2,3,7,8-tetrachlorodibenzo-*p*-dioxin" and "dibenzofuran." These two substances are part of a much larger class of compounds, as discussed below.

Dibenzo-*p*-dioxin and dibenzofuran molecules both carry single hydrogen atoms bonded to carbon atoms at the outside corners. When chlorine atoms are substituted for any (or all) of these hydrogens, the compounds become chlorinated dibenzo-*p*-dioxins and chlorinated dibenzofurans (CDDs and CDFs). The presence of chlorine may increase the toxicity of the compound by many orders of magnitude, depending on their number and location. There are 75 possible CDD compounds and 135 possible CDF compounds. Each of these individual CDD and CDF forms is called a "congener." It is these CDD and CDF congeners that are commonly referred to as "dioxins" and "furans." The terms "dioxins" or "TCDD" and "furans" or "TCDF" are used in this report to refer to all CDD and CDF congeners, respectively.

### *Relationship of Pollutants of Concern to Section 112 and Other CAA Requirements*

Table I-2 presents the section 112 requirements that may regulate emissions of each pollutant of concern. As shown, emissions of mercury are covered most comprehensively by section 112 requirements, followed by emissions of lead compounds, POM, TCDD, and TCDF. (Emissions of lead compounds also are regulated under the CAA Title I criteria air pollutant program.) Emissions of hexachlorobenzene and PCBs may be regulated under the maximum achievable control technology (MACT) standards required by sections 112(d), (g), and (j), and under 112(c)(6). Emissions of cadmium compounds are covered under the MACT standards and, for electric utility steam generating units, under 112(n)(1)(A). For several pesticides, the development of MACT standards is the main section 112 requirement that may control emissions of these pollutants, to the extent that major sources of air emissions still exist in the United States. Section 112(f), which is not included in the table, is intended to address the public health risks and adverse environmental effects from HAP

**TABLE I-2**  
**Great Waters Pollutants of Concern and CAA Section 112**

Pollutant	Applicable CAA Section 112 Activities <sup>a</sup>					
	112(b)	112(c)(6)	112(d),(g),(h),(j)	112(n)(1)(A)	112(n)(1)(B)	112(n)(1)(C)
Cadmium and compounds	●		●	●		
Chlordane	●		●			
DDT/DDE	●		●			
Dieldrin						
Hexachlorobenzene	●	●	●			
α-HCH	●		●			
Lead and compounds <sup>b</sup>	●	●	●	●		
Lindane	●		●			
Mercury and compounds	●	●	●	●	●	●
PCBs	●	●	●			
Polycyclic organic matter (POM)	●	●	●	●		
TCDD (dioxins)	●	●	●	●		
TCDF (furans)	●	●	●	●		
Toxaphene	●		●			
Nitrogen compounds <sup>c</sup>						

<sup>a</sup> 112(b) = HAP list; the pollutants of concern are regulated under section 112 only by their name as listed in section 112(b) (cadmium compounds, chlordane, DDE, hexachlorobenzene, lindane (all isomers, which includes α-HCH), lead compounds, mercury compounds, PCBs, POM, 2,3,7,8-TCDD, dibenzofurans, and toxaphene).

112(c)(6) = Sources accounting for 90 percent of these emissions to be subject to regulation

112(d),(g),(h),(j) = Emissions of HAPs from major sources subject to regulation by MACT standards

112(n)(1)(A) = Emissions of these six HAPs from electric utility steam generating units to be evaluated for regulation

112(n)(1)(B) = Emissions of mercury from electric utilities, municipal waste combustors, and other sources to be studied

112(n)(1)(C) = Report required on "threshold" level for human health effects from mercury

Does not include section 112(f), which is intended to address the public health risks and adverse environmental effects from HAP emissions remaining after implementation of 112(d) standards.

<sup>b</sup> Lead compounds also regulated under the criteria air pollutant program.

<sup>c</sup> Nitrogen oxides (NO<sub>x</sub>) regulated under several other CAA programs, such as those that control criteria air pollutants, mobile source emissions, and acid rain.

emissions remaining after implementation of section 112(d) MACT standards; these standards could apply to any HAP for which it is determined that "residual risk" remains. Emissions of dieldrin and nitrogen compounds are not currently addressed by the section 112 requirements listed in Table I-2. Emissions of certain nitrogen compounds, however, are regulated under several CAA programs other than section 112, including the Title I criteria air pollutant program, the Title II mobile sources program, and the Title IV acid deposition program.

Other sections of the CAA may also regulate emissions of the pollutants of concern. For example, under section 129 of the CAA, which applies to municipal waste combustors, EPA is to develop numerical emission limitations for several pollutants, including the following Great Waters pollutants of concern: cadmium, dioxins, furans, lead, mercury, and nitrogen compounds (nitrogen oxides).